Partitioned Radio Transceiver Modules
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This white paper defines Partitioned Radio Transceiver Modules and explains the regulations/guidelines that the FCC is developing to certify these solutions in OEM systems.

Background. Until recently, manufacturers did not sell radio transmitters as parts of other systems, but rather sold radio transmitters as standalone devices (e.g., walkie talkies). However, with the advent of the Internet and email, manufacturers of notebooks and other portable devices are focusing on "anywhere anytime" data communications as a prime business opportunity.

In order to take advantage of this business opportunity, manufacturers want to include wireless radio transmitters in their end user systems. The inclusion of these transmitters raises an FCC regulatory/certification issue; each end user system that includes a transmitter must be individually certified for regulatory compliance to transmitter operation and then evaluated for compliance to emission regulations in the individual OEM system. Thus, if a manufacturer wants to include a radio transceiver in its system, each system implementation must be individually certified (even if the transmitter layout and implementation is identical). In addition, if a transceiver manufacturer sells to different OEM's, the transceiver system must be certified many times (i.e., once for each implementation). This certification process can take up to six months for each system and must be repeated for each regulatory body around the world. These multiple, time consuming certifications have become a significant regulatory burden for OEM's, thereby delaying the "time-to-market" for their products.

Modular Transceivers. Faced with this substantial regulatory burden, the FCC and industry developed the concept of modular transceivers. A modular transceiver is a "self contained" transceiver where the only connections to the device are: 1) data/modulation input, 2) power;,and 3) an antenna (see Figure 1).
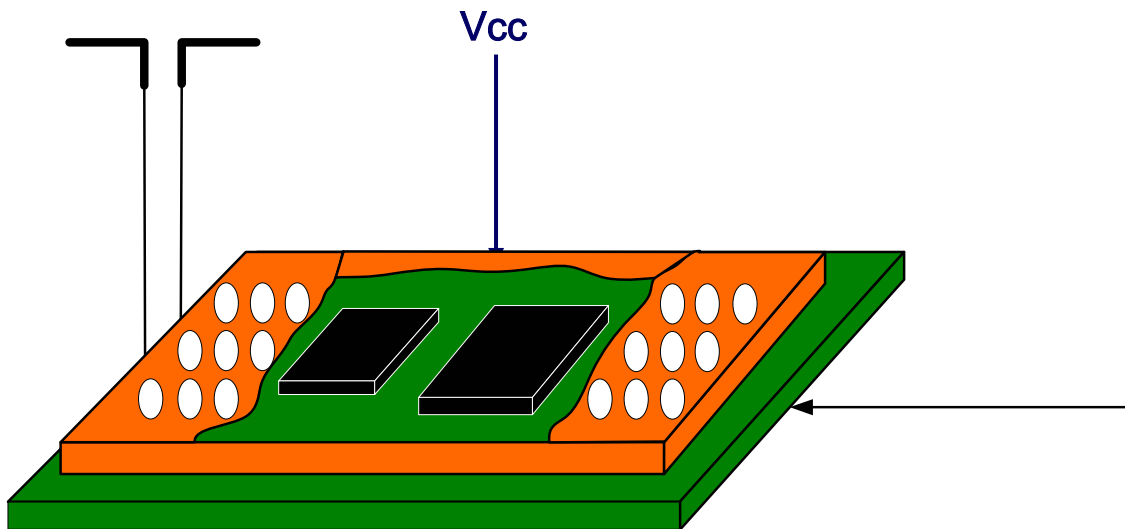
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Figure 1

In developing the concept of modular transceivers, the industry (in conjunction with the FCC) defined a certification process whereby each "module" will only need to be certified once, after which it can be used in any system without having to recertify the transceiver (assuming use of the same antenna). In order to accomplish this goal, there are certain requirements that the module needs to meet.

These requirements are:

1. **The module must be shielded.** The module must meet all of the conducted and radiated emmisions requirements in this "standalone" configuration.

2. **The modular transceiver must have buffered modulation/data inputs.** This requirement ensures that the module will comply with FCC Part 15 under conditions of excessive data rates or over-modulation.

3. **The module must have its own regulator.** This requirement ensures that variation in the supplied power will not change the transmitted output power of the system.

4. **Antennas used must meet the requirements defined in the CFR Title 47 Part 15, Sections15.203 and 15.204(c).** The antenna must be either permanently attached or employ a "unique" antenna coupler for any connection to the module. Any antenna used with the module must be approved with the module, either at the time of initial authorization or through a Class II permissive change. (Note: The "professional installation" provision of Section 15.203 is not applicable here.)

5. **The module must be tested for regulatory compliance in a stand-alone configuration** (i.e., the module must not be inside another system during certification testing). No cable connected to the module may use ferrites unless they will be marketed with the final solution.

6. **The modular transmitter must be labeled with its own FCC ID number.** If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module.

7. **The modular transmitter must comply with any specific rule or operating requirements applicable to the transmitter.** The manufacturer must provide adequate instructions along with the module to explain any such requirements.

8. **The modular transmitter must comply with any applicable RF exposure requirements.**

FCC Public Notice **DA 00-1407** (June 26, 2000) outlines the above rules. These rules are currently being used for many Bluetooth and Wi-Fi implementations. However, they do not go far enough. Indeed, if a manufacturer wants to integrate a portion of the transceiver into a host platform, the manufacturer must revert back to the original time consuming, burdensome multiple certification process.

<u>**Formalizing the Certification Process to Deal with Integration.**</u> In order to accomodate these integration issues, the FCC is in the process of formalizing the module certification process and adding new provisions for splitting the module into two separate components. This formalized and expanded certification process would only apply to a complete system.

The certification process will specifically define the following the pieces of the transceiver:

1. **An Antenna** – The same requirements as a standard module

2. **A Front End (FE)** – This component is shielded, and is the place where any circuitry that needs to be shielded resides.

3. **A Radio Platform Component** – This component houses all parts of the transceiver that are not contained in the FE. By definition, this component is defined by firmware which resides inside this silicon.

Figues 2 and 3 show this partitioned architecture. Figure 2 depicts a "stand-alone" radio platform component. Figure 3 shows the Radio Platform component integrated into another piece of silicon.
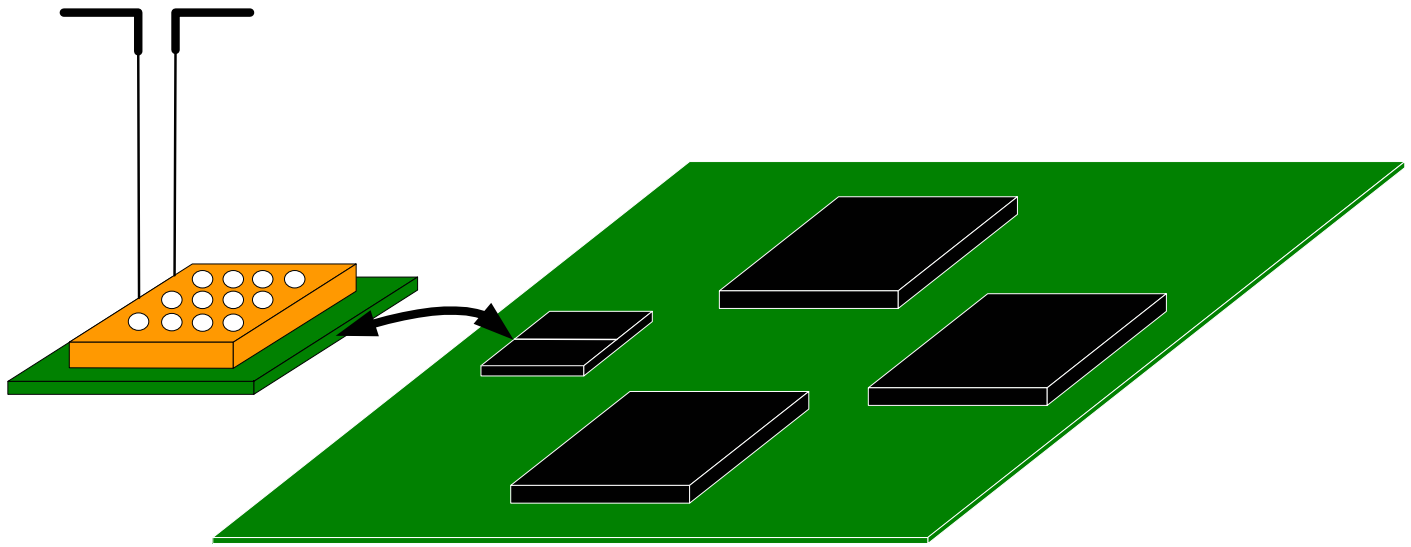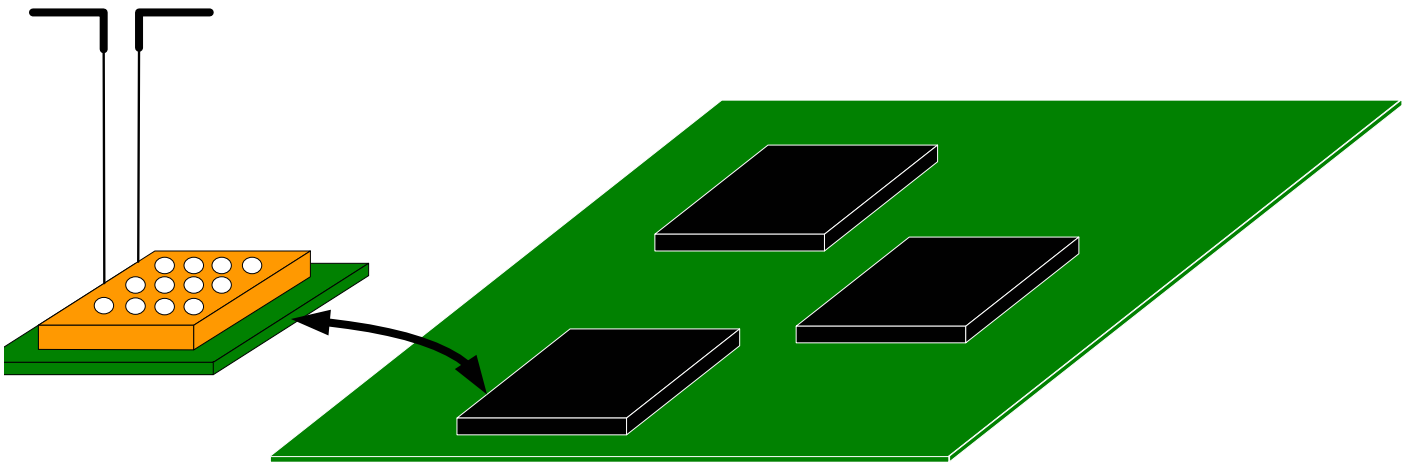
Figure 2

Figure 3

<u>Radio Components in Partitioned Module Architecture.</u> There are two radio components used in the partitioned module architecture: the Front End (FE) and the Radio Platform component. (Note: The antenna requirements do not change).

The Front End component:

1. The FE includes the transceiver reference clock/oscillator and any other oscillator that requires shielding (Note: The physical crystal and the two tuning capacitors may be located "off/outside" of this unit due to physical constraints. This characteristic also applies to the single module transceiver).

2. A voltage regulator needs to be located on the FE to ensure that the RF output power does not change when the supply voltage is varied.

3. The FE is shielded and needs to comply with applicable FCC Part 15 emission requirements when tested in a "stand-alone" configuration.

4. The FE contains an ID which is composed of (1) Company Information and (2) Device Number. This "ID" or type number consists of a digital word four bytes in length with the following bit definition: 16 bits for the Company Information and 16 bits for the Device Number.

The Radio Platform component:

1. This unit houses all of the radio components that are not present in the FE.

2. It houses a verification mechanism to validate the firmware necessary to control/operate the transmitter. Validation of the firmware and the FE must occur before the system is allowed to transmit.

3. This unit must validate that the FE has been certified for operation with the current firmware revision. The FE "ID" shall be used for that purpose, and the radio must not be allowed to transmit before this validation occurs.

4. This unit provides the execution space for the radio's transmitter firmware.

5. The radio's transmitter firmware in essence defines the hardware implementation and must run unmodified in any instansitation of the radio platform component. This firmware is listed as part of the certification process in the grant for the radio system.

6. This unit must not use other platform resources for any of the transmit functions. It needs to maintain platform independence for the operation of the transmitter.

The interface between the FE component and the Radio Platform component is defined with the following minimum requirements:

1. Digital signaling must be used between the two radio components.

2. 150 mVPP is the minimum signaling amplitude allowed on the interface. Discrete multilevel signaling is permitted, but analog signaling is not allowed. The reason for not allowing analog signaling is because it is susceptible to platform interference and it could not be demonstrated that the transmitter output would not contain spurious emissions.

3. Any type of information (control, radio functionality, and/or data) may be passed between the two radio components across this interface.

4. The maximum length of cabling between the FE and Platform component is ten cms without specifying the cable type, shielding requirements, and maximum length that will be used in the grant.

5. Use of optical signaling between the FE and platform component is permitted. There are no restrictions on the signaling type, and any kind of information can be sent over this link.

Advantages of the Partitioned Radio System. The component and interface definitions above outline a radio system that can be integrated onto a platform and meet the "certified once and use anywhere" criteria. These generalized component level descriptions leave most of the architectual decisions to the radio designers, while providing them a partitioning framework that will satisfy regulatory requirements.

Some of the advantages of this approach to radio integration are:

1. Location of the FE next to the antenna to reduce/eliminate a long coax run provides a performance improvement without changing the radio design.

2. The ability to combine the platform component silicon with other silicon on the platform as long as a set of minimum requirements are met, resulting in cost savings.

3. The radio manufacturers can certify a partially integrated, motherboard down solution for their customers.

Example Certification Process for the Partitioned Radio System. The radio manufacturer develops a "reference design" which is used to represent the host platfom. It contains the platform component of the radio, as well as host components necessary to access the data and to establish communications with another radio. The design also should be able to place the radio into a test mode for

the purpose of radio evaluation. A maximum length interface cable is connected to the FE module along with an antenna which will be included in the final grant. The radio system must be in a "stand-alone' configuration (i.e., it cannot be housed inside another system for the purpose of the regulatory testing).

The radio manufacturer then "downloads" the firmware which will be used to control the radio. The firmware must then be verified by the platform component as being authentic. Then, the firmware must verify that the FE has been approved for use with this version of the firmware. Once this verification is complete, the radio testing can proceed. (Note: The radio manufacturer will need to provide details of the firmware protection mechanism to the regulatory authorities describing the methods used to prevent malicious modification of the firmware.)

Next, the radio system must be tested for compliance with Part 15 specifications and spurious emissions guidelines. In additions to the normal spurios emissions testing, interferring signals need to be injected into the interface cabling and demonstrate that they do not adversely effect the transmitted output. A radio grant will then be issued defining the three components of the partitioned solution: one or more antennas; one or more FE's; and a firmware version defining the radio. (Note: So long as the firmware runs unmodified on the final radio platform component, no restriction is placed on the implementation form of the radio platform component on the reference platform.)

Radio manufacturers may test multiple FE and antennas during this process so that they can provide different choices to their customers.

Summary. The partitioned architecture for radio transceiver modules allows a portion of a radio to be integrated into a host platform, and still take advantage of the significant time and cost savings of the module approval process.

Appendix A – Proposed Criteria for a Module Approval Radio Grant:

- (1) The radio elements of the modular transmitter must have their own shielding. If the modular transmitter consists of two or more partitioned sections, the interface between the sections of the modular system must be digital with a minimum signaling amplitude of 150 mV peak-to-peak. The physical crystal and tuning capacitors for partitioned modules can be located external to the shielded radio elements.

- (2) The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with Part 15 requirements under conditions of excessive data rates or over-modulation. For partitioned modules, control information and other data may be exchanged between the firmware and radio front end.

- (3) The modular transmitter must have its own power supply regulation.

- (4) The modular transmitter must comply with the antenna requirements of Section 15.203 and 15.204(c). The antenna either must be permanently attached or employ a "unique" antenna coupler (at all connections between the module and the antenna, including the cable). Any antenna used with the module must be approved with the module, either at the time of initial authorization or through a Class II permissive change. The "professional installation" provision of Section 15.203 may not be applied to modules.

- (5)   (a) The modular transmitter must be tested in a stand-alone configuration (i.e., the module must not be inside another device during testing). Unless the transmitter module will be battery powered, it must comply with the AC line conducted requirements found in Section 15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will be marketed with the module (see Section 15.27(a)). The length of these lines used during testing shall be a length typical of actual use or, if that length is unknown, at least ten centimeters to insure that there is no coupling between the module case and supporting test equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified or commercially available (see Section 15.31(i)).

- 　　　　(b) A module comprised of two or more sections must be tested while installed on a reference platform or final host device. Signal injection testing shall be performed on the implementation with a length of cable not exceeding ten centimeters that connects the module components and platform.

- (6) The modular transmitter must be labeled with its own FCC ID number. If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label

referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: XYZMODEL1" or "Contains FCC ID: XYZMODEL1." Any similar wording that expresses the same meaning may be used. The Grantee may either (i) provide such a label, an example of which must be included in the application for equipment authorization or (ii) provide adequate instructions to parties that may include the module in their product (i.e., the Grantee must state that such a label must be placed on the outside of the device). In the latter case, a copy of these instructions must be included in the application for equipment authorization.

- (7) The modular transmitter must comply with any specific rule or operating requirements applicable to the transmitter, and the manufacturer must provide adequate instructions along with the module to explain any such requirements. A copy of these instructions must be included in the application for equipment authorization.

- (8) The modular transmitter must comply with any applicable RF exposure requirements.

- (9) The type number of a partitioned module must consist of a digital word four bytes in length with the following bit definition: 16 bits for the Company Information and 16 bits for the Device Number.